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The development of the embryo-sac of Nymphaea advena *

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(WITH PLATES 18 AND 19)

The taxonomic position of the water-lilies or Nymphaeaceae has always been doubtful because of their peculiar and seemingly inconsistent characteristics. The closed vascular bundles, irregularly placed through the stem, are characteristic of monocotyledons, but the reticulate venation of the large peltate leaves is a dicotyledonous character, while the flowers might belong to either class. Moreover, the fruit presents peculiarities that have been interpreted in various ways. Early investigators studied the seed of nearly or quite mature fruit. Recent investigators, using younger material, have, by their studies of development, made clear points not hitherto known. In 1901, H. L. Lyon declared that "the embryo of *Nelumbo* is genuinely monocotyledonous in its development. The plumule arises laterally and at first there is but one cotyledon which later bifurcates to form the two fleshy bodies." The fact that the radicle does not function is another respect in which *Nelumbo* conforms to well-known monocotyledonous types. Because of the characters of the embryo as well as of the mature plant, Lyon concluded that the Nymphaeaceae should be classified among the monocotyledonous families in a subseries coördinate with the Potamogetonineae, Alismineae, and Butomineae, in the series Helobiae.

In 1902, M. T. Cook followed Lyon with his paper on the embryogeny of *Castalia odorata* and *Nymphaea advena*, in which he confirmed the views already given. In 1904 Schaffner, in his

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paper on morphological peculiarities of Nymphaeaceae and Helobiae, agreed with Lyon and Cook as to the monocotyledonous embryo and vascular bundles, and went farther in saying that he found even the flower could be made to fit into the monocotyledonous scheme. The six sepals of *Nymphaea advena* could be considered a perianth typically trimerous with three sepals and three petals. Even in *Castalia odorata*, said to have four sepals, the sepals are normally three in a cycle, but sometimes there is an expansion of the receptacle causing one sepal of the second cycle to be brought outside. Schaffner maintains that many superficial characteristics of secondary importance, such as similarity to Helobiae in habitat, rhizome habit, leaf forms, and number and arrangement of ovules in ovularies, add strength to the monocotyledonous idea. The embryo of *Castalia odorata* which Conard finds "to have two cotyledons from the first," Schaffner, by dissecting out very young embryos, found to show a resemblance to *Nelumbo* and *Nymphaea* that could much less easily be seen in serial sections. Schaffner concludes his paper with the prediction that with our increasing knowledge of the embryogeny of angiosperms we shall be inclined to divide them into a number of parallel groups rather than maintain the two of our present classification, dicotyledons and monocotyledons. Perhaps a similar idea is expressed in another form by Mottier who calls the Nymphaeaceae anomalous dicotyledons.

Since Cook's paper on embryogeny was based upon the first stages of the development from *Castalia odorata* material, and the later stages from *Nymphaea advena*, I give my own study of the development of the embryo-sac, based altogether on abundant material of *Nymphaea advena* in all the stages.

THE EMBRYO-SAC OF NYMPHAEA ADVENA

The material was collected at Ithaca, N. Y., and Cleveland, Ohio. Twice in July, and again twice in August, for three consecutive summers, buds and flowers of various ages were collected in the bayous of Fall Creek and in the Inlet of Cayuga Lake at Ithaca. In September, at the same place, several plants were uprooted and from the crown small young buds, formed for the next season, were obtained. As these proved to be too young to

show the floral parts, no further material was gathered in the autumn, but collections were made for two consecutive seasons in May, from a small lake thirty miles east of Cleveland. From every collection made, buds and open flowers of varying size and general appearance were selected. Although floating buds of any given collection showed a wide range of gross development, very little variation in the condition of the embryo-sac was found in such material; that is, size and general external appearance are no definite guide to internal development in this species. The season, rather than the gross appearance, is the best criterion of the conditions of development.

Material collected in July and August was carried to the laboratory for killing and fixing; that gathered in May was put in the fixing fluid at the place of collection. At first, the outer floral parts were removed and the pistil cut vertically into from eight to twelve radial pieces, but later all except the youngest ovules were removed from the pistil and fixed separately. In removing the ovules, the large quantity of gelatinous substance made the work difficult. Flemming's chromo-aceto-osmic mixture and chromo-acetic acid were used. Because of the gelatinous substance surrounding the ovules, Wager's alcoholic fixer was tried, but the aqueous fixers gave much better results. The separate ovules, when of small size, were slightly stained *in toto*, with picro-carmine after fixing, in order that they might be more easily seen during subsequent treatment in grades of alcohol, cedar oil, and in paraffin. Sections of varying thickness were cut and stained with different stains, Flemming's triple stain giving the best results. A large number of slides was prepared and all the points figured were observed in many preparations.

This investigation was carried on in the botanical laboratory of Cornell University, under the direction of Professor Atkinson and with the assistance, at first, of Dr. Margaret C. Ferguson and later of Dr. E. J. Durand.

In May, before the integuments begin to develop, a single hypodermal archesporial cell can be distinguished (*figure 1*). This hypodermal cell divides by a transverse wall into an upper cell, the primary parietal cell, and a lower one, the megaspore mother-cell (*figures 2, 3*). The primary parietal cell divides irreg-

ularly, so that the megaspore mother-cell is soon seen to be buried four cells deep (*figure 6*). It expands somewhat and is marked by an abundance of cytoplasm (*figure 5*). At the time of the division of the hypodermal cell, the beginning integuments can be seen, in section, as rounded protuberances from the base of the ovule (*figure 2*). The megaspore mother-cell soon divides transversely into two cells. The succeeding divisions are somewhat irregular. Usually the micropylar daughter-cell next undergoes division (*figure 7*) and after that the chalazal cell, but sometimes the chalazal cell divides first. At other times after the micropylar cell has divided so that a row of three cells has been formed, the middle cell next divides instead of the lower one. Whatever be the succession of divisions, they result in the normal production of an axial row of four cells, or "megaspores," of which the lower one is functional. I have an abundance of material showing the above steps. By irregular divisions of the parietal tissue and of the epidermal tissue at the tip of the ovule simultaneously with the formation of the four megaspores, the functional "megaspore" or embryo-sac mother-cell is buried to the depth of from six to ten cells below the micropylar end of the ovule. The functionless megaspores then degenerate (*figure 9*) so that the embryo-sac mother-cell lengthens toward the micropyle (*figure 10*).

The embryo-sac mother-cell enlarges in the direction of the longitudinal axis of the ovule in the two-nucleate stage (*figure 11*), and broadens in the four-nucleate stage (*figure 12*). The mature embryo-sac further expands toward the micropyle until it is within eight, six, or even four cells of the micropylar end of the ovule (*figures 17, 18*), but never extends to the superficial row of cells as Cook found in *Castalia odorata*. The nucellar tissue between the upper end of the embryo-sac and the micropyle at this time assumes a characteristic appearance; the cells seem crowded, as they are smaller and more compact than at any previous time. They are also arranged in very regular rows. The cytoplasm is so abundant as to leave no vacuoles in these cells and they appear to be stored with food (*figure 17*). At the time the embryo-sac has reached the eight-nucleate stage it occupies one half the length of the ovule (*figure 13*). The polar nuclei fuse and the antipodals soon disappear. The fusion-nucleus is very large (*figures 15, 17*).

Dense cytoplasm surrounds the egg-apparatus, but it is scanty in the rest of the sac, thin streamers extending from the egg-apparatus to the large endosperm-nucleus and from that to the antipodal end of the sac, often following the general direction of the sides but not touching them.

The early embryo-sac appears elliptical in section. The shape of this part of the sac does not change, but in the eight-nucleate stage, at the antipodal end, there is formed a tube-like elongation, which in time reaches to the chalazal end of the ovule. This basal prolongation is always narrower than the older part at the micropylar end of the sac and seldom has a liberal supply of cytoplasm (*figure 13*). At the juncture of the tube-like lower part with broad elliptical upper part of the embryo-sac is a constriction. It is in this constricted part that the large fusion-nucleus or endosperm-nucleus lies. Although the sac lies straight in the axis of the ovule, occasionally, in sectioning, cells from the surrounding tissue appear to be in the sac. These fragments may have given rise to the idea that a cross-wall appears in the sac at this point at the time of the division of the large endosperm-nucleus, which, as stated, always lies in this constricted part (*figures 13, 16*). In my material, this endosperm has been observed soon after division, but a cross-wall in the embryo-sac between the two nuclei, such as described by Cook for *Castalia odorata*, has not been seen. The endosperm-nucleus lying in the constricted part of the sac then divides into two. The upper endosperm-nucleus later divides to form the endosperm tissue while the lower (antipodal) endosperm-nucleus moves down into the chalazal end of the tube-like portion of the sac, enlarges, and often persists until the embryo is quite advanced (*figure 21*). Soon after fertilization of the egg-nucleus the perisperm shows an accumulation of starch. This food supply is remarkably abundant in all the older ovules studied (*figure 20*).

After fertilization the cytoplasm of the sac always gathers about the fertilized egg in a spherical mass. It is vacuolate, with thread-like dense portions radiating from the nucleus to the surface of the sphere of cytoplasm. The cytoplasm from the pollen-tube is dense and takes the stain deeply (*figure 14*). One synergid persists and is very similar to the fertilized egg in appearance

except that it lacks the surrounding regular-shaped mass of cytoplasm. The endosperm-nucleus in the constriction of the sac sometimes divides at this time but usually later. The lower endosperm-nucleus in the chalazal end of the long tube-like portion of the sac is very large and conspicuous with a reticulated surface and a large dense nucleolus (*figures 14, 19*).

The young embryo is nearly spherical, lying against the wall at the micropylar end of the sac, and is nearly surrounded by endosperm. This endosperm tissue is surrounded by perisperm containing a rich food supply. The endosperm tissue never extends into the tube-like base of the embryo-sac but the nucellus closing in from the sides obliterates it, often leaving only the cavity at the extreme chalazal end containing its persisting nucleus (*figures 20, 21*).

SUMMARY

1. The hypodermal cell can be distinguished before the integuments begin to develop.

2. The integuments begin to develop at the time of the division of the hypodermal cell.

3. By the division of the parietal cell the megaspore mother-cell is buried four cells deep.

4. The order in which the four cells of the axial row arise varies, but the lowest one always functions.

5. By simultaneous division of the epidermal and the parietal tissue the embryo-sac is buried six to ten cells below the micropylar end of the ovule.

6. The functionless megaspores degenerate so that the embryo-sac mother-cell lengthens toward the micropyle.

7. The embryo-sac expands until within eight, six, or even four cells of the micropylar end of the ovule, but never to the superficial row of cells as Cook found to be the case in *Castalia odorata*.

8. The nucellar tissue between the upper end of the sac and the micropyle assumes a characteristic appearance; cells crowded, small, dense, in regular rows and stored with food.

9. The eight-nucleate embryo-sac develops a tube-like prolongation toward the chalazal end of the ovule. This tube is always narrower where it joins the broadly elliptical upper part of the sac than throughout the rest of its extent.

10. The large fusion-nucleus lies in the narrow part of the tube-like prolongation of the embryo-sac.

11. When this fusion-nucleus divides, it does not form a wall across the embryo-sac as Cook found in his material.

12. The scanty cytoplasm of the embryo-sac gathers around the fertilized egg in a characteristic manner.

13. The fusion-nucleus may divide at the time of fertilization of the egg but usually this occurs later.

14. The lower endosperm-nucleus, arising from the division of the fusion-nucleus, travels to the chalazal end of the tube-like part of the sac and persists until the embryo has attained considerable size.

15. The embryo is spherical, lying against the wall, almost surrounded by endosperm, within the perisperm, rich in food.

16. The Nymphaeaceae are monocotyledonous in embryology, vascular tissue, habit, and possibly even in floral arrangement.

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Explanation of plates 18 and 19

All figures were drawn with the aid of an Abbé camera lucida.

FIG. 1. Nucellus with archesporial cell.

FIG. 2. Archesporial cell dividing.

FIG. 3. The primary parietal cell and the megaspore mother-cell.

FIG. 4. Two parietal cells and the megaspore mother-cell.

FIG. 5. The enlarged megaspore mother-cell.

FIG. 6. The megaspore mother-cell buried four cells deep by the increase of parietal tissue.

FIGS. 7 and 8. The dividing micropylar cell in the axial row of megaspore-cells.

FIG. 9. The functional megaspore, with the degenerating functionless megaspores.

FIG. 10. The division of the embryo-sac mother-cell.

FIG. 11. The two-nucleate stage of the embryo-sac.

FIG. 12. The simultaneous division of the two nuclei to form the four-nucleate sac.

FIG. 13. An ovule with a mature embryo-sac, after fusion of polars and disappearance of antipodals; showing the position in ovule and relative size of the sac.

FIG. 14. Entire embryo-sac, showing characteristic appearance and arrangement of sac-nuclei just after fertilization.

FIG. 15. Mature embryo-sac, showing egg-apparatus and endosperm-nucleus.

FIG. 16. An ovule, showing embryo-sac ready for fertilization.

FIG. 17. Upper end of a sac, showing condensed cells between sac and the micropyle.

FIG. 18. The upper part of sac no. 14, showing details.

FIG. 19. The lower part of sac no. 14, showing details.

FIG. 20. The embryo with endosperm tissue and perisperm tissue containing starch.

FIG. 21. The chalazal end of ovule in 20, showing the persisting lower endosperm-nucleus.

Notes on Lycoperdon sculptum Harkness

WILLIAM ALBERT SETCHELL

(WITH PLATE 20)

The large puffball of the Sierra Nevada Mountains of California was first made known in 1885 by Dr. H. W. Harkness, in the first volume of the Bulletin of the California Academy of Sciences (page 160), with the general statement that it is "found only at considerable elevations, 6,000 to 8,000 feet in the Sierra Nevadas." In conversation several years since, Dr. Harkness told me that the original specimens came from some locality on the eastern slopes, but he seemed uncertain as to the exact locality. At that time, the "Harkness Collection of Fungi," which had been given to the Academy, was not in order and I was unable to make any search. The type, however, was preserved as a museum specimen under glass with no data accompanying it. After the death of Harkness, the collection was placed in order by Miss Alice Eastwood, curator of the herbarium and I made an examination of all the specimens of this species contained in it with notes as to my results. I found only one specimen with the locality marked and that came from near Summit in Placer County, at an altitude of about 6,700 feet. This is probably, then, to be considered as the type locality.

In the herbarium of the University of California, there are several good specimens of this species and with satisfactory data. One came from Summit, our supposed type locality, where it was collected by Mrs. Charles H. Shinn. One of the earliest specimens to be received at the University was collected by Mr. D. T. Fowler, in Sierra Valley, in Sierra County, at an altitude estimated by him to be about 4,800 feet. He also reports finding several specimens along the road between Sierra Valley and Truckee. These collections were reported by J. Burtt Davy in the "Reports of the work of the Agricultural Experiment Station of the University of California for the years 1898–1901" (page 353), under the name of *L. insculptum* (error in copying). Several specimens in perfectly ripe condition were collected by C. C. Dobie and myself

in the neighborhood of Emerald Bay, Lake Tahoe, at about 6,500 feet in 1901. They were so mature that they fell to pieces during transportation to Berkeley. There is a specimen, somewhat immature, collected by H. N. Bagley in June, 1902, at Tamarack Flat, on the Big Oak Flat Road in Mariposa County, at an altitude of 6,400 feet. Finally there have recently been added to the herbarium specimens collected by Dr. H. M. Hall, at Bluff Lake in the San Bernardino Mountains in July, 1908, at an altitude of 8,300 feet. Besides these specimens in the herbarium of the University of California, there are a few in other collections known to me. Lloyd mentions in his Mycological Notes (No. 18, page 203, 1904) that he had received a specimen from Professor W. C. Blasdale collected near Lake Tahoe and that there is in the herbarium at Kew, some ripe gleba sent by Harkness. The specimens of Harkness were destroyed in the fire of April, 1906, which destroyed as well the buildings and most of the collections of the California Academy of Sciences. I learn from Mr. S. B. Parish of San Bernardino, that he also collected a specimen at Bluff Lake, the same locality whence Dr. Hall procured his specimens, and sent it to the late A. P. Morgan, in whose collection I presume that it may still be found. These are all the collections known to me.

In 1906, I published in the Sierra Club Bulletin (**6**: 39) a popular description of this puffball under the title of "The Sierran Puffball" and illustrated it with photographs. It was really an appeal to members of the Sierra Club to note the occurrence and report localities and altitudes at which they might find it. As a response, several members of the Club have told me of specimens seen and with sufficiently definite information as to appearance to make it reasonably certain that it was this and no other species observed. This information, with an item received before the publication of the article, I append as hearsay, but none the less, credible evidence as to range in latitude and altitude. The late Professor J. J. B. Argenti, of San Francisco, evidently found it at Crane Flat, on the Big Oak Flat Road, at an altitude of 6,300 feet. Professor C. B. Bradley, of Berkeley, reports it from the head of Bear Valley, in Alpine County, at an altitude of 6,500 feet. He found it in 1895. Mr. H. O. Wood, of Berkeley,

reports it from above Lake Tenaya, in Mariposa County, at an altitude of between 8,200 and 8,300 feet. Mr. William E. Colby, of San Francisco, Secretary of the Sierra Club, found it in the Tuolumne Meadows, at about 8,500 feet and, tasting the raw flesh, found it to be very agreeable in flavor. Mrs. Katherine Brandegee, of Berkeley, saw some specimens collected by others in the Giant Forest of the Sequoia National Park, at an altitude of about 6,500 feet.

From the evidence given above, it seems well ascertained that the distribution of *Lycoperdon sculptum* extends at least from Sierra Valley on the north, down along the Sierra Nevada and San Bernardino Mountains to Bluff Lake and that in altitude, it ranges from 4,800 feet up to 8,500 feet. The striking range as regards altitude, as well as the extraordinary markings of this species may well make one wonder as to whether it is likely to be retained in *Lycoperdon* or one of its segregates, or made the type of a distinct genus. While I do not intend to attempt to settle this question, it seems desirable to add some description of the species drawn from both the living and the dried specimens.

So far as I may learn, *Lycoperdon sculptum* is most usually found in alluvial soil and often among the willows which border small streams, but it is also found in the drier soil under pines and perhaps also under *Sequoia gigantea*. As I found it myself, there were nearly a dozen specimens in the same small area, but often single specimens are found with no others near them. They are fairly conspicuous objects up to the time that the peridium falls away and exposes the spores. The peridium retains its light color until maturity.

The shape of a well-developed specimen is that of a pear, somewhat, or even considerably, flattened laterally. The size varies from about 10 to 20 cm. in the longest horizontal diameter and the plants reach a height of 10 to 15 cm. The sterile base of the puffball is stout, usually buried in the ground, and it has the remnants of stout mycelial strands at its very base. This is well represented in the upper and left middle specimens in the photograph reproduced in connection with this paper. The upper portion of the puffball is sometimes nearly globular, but is generally very decidedly flattened laterally and has the outer peridium

broken up into coarse pyramidal areas which surpass in size, especially in height, those of any known puffball, unless it may be such species as those of *Phellorina* or *Scleroderma strobilinum*. These pyramidal projections in *Lycoperdon sculptum* are well represented in the right middle specimen in the accompanying plate, which, however, is reduced to one half the proper diameter. They are often as much as 3.5 cm. in basal diameter and reach a height of 3 cm.; they taper to a more or less sharp apex, which is generally incurved, and are marked with horizontal lines, representing the layers of the thick outer peridium. They are reasonably well shown in the original figure of Harkness (*loc. cit.*) but do not show very well in the figure given by Lloyd (*loc. cit.* 203. *f. 81*). They remain persistent until the final breaking up of the whole peridium, not in any way appearing to be evanescent or caducous.

Many specimens of *Lycoperdon sculptum* are affected by the attacks of insects or by dry conditions, or some other influence, so that they do not develop beyond a certain stage, such as is represented in the two lowermost figures in the photograph which accompanies this paper. They become somewhat mummified and in this condition are easily transported and preserved. They show fairly well the main external characters of the projections, but do not reach the normal size or attain the normal shape. The specimen figured by Lloyd (*loc. cit.*) seems to be one of this sort. Such specimens well represent stages in development, but not the typical adult plant.

The gleba, in well-developed specimens, is white at first, later turning yellowish, then an intense yellow and finally a decided umber, as the spores ripen. It is early readily separable from the peridium and from the tissues of the stipe. The spores are rough and about 2–3.5 μ in diameter, light yellowish and nearly smooth when young, becoming dark and slightly but evenly warted when mature. Harkness, and all who follow him, say that the spores are smooth, and young spores, which, judging from the descriptions of the color of the gleba ("yellow") are all that they have had to examine, appear smooth, but, in the really mature glebae which I have, the spores are plainly rough even with ordinary high powers, while with the one-twelfth inch oil-immersion, the regular warted character is plainly to be seen. The size of the spores is the same

in all the mature specimens that I have been able to examine and differs from that as given by Harkness, viz., "5–8 μ," in that the average runs from 2 μ to 3.5 μ. Occasionally a larger spore is seen, but I have not been able to obtain any measurements approaching those of Harkness. The capillitium threads, in the really matured specimens, are thick-walled and of the same color as the spores. They are short and very seldom show any branching at all. For the most part, the ends appear broken, but in some cases they are rounded.

I have chosen to use the name for this species which was given to it by Harkness. There seems to be no definite agreement as yet as to just how and upon what characters the genus *Lycoperdon* shall be segregated. In the matter of dehiscence, however, it does not belong to that section of the genus whose members open by means of an apical pore, but rather to that section in which the peridium breaks up into plates which, falling off, gradually expose the whole ripened gleba. This brings the species into the genus *Calvatia* in the sense in which it is used by some authors. It is also "stipitate," and this may be another reason for considering it to belong to this genus, should it be decided to keep it distinct. It has already been referred to *Calvatia* by Lloyd (*loc. cit.*, under "*Calvatia sculptum*"). As to its relation to the genus *Areolaria*, or as to its being the type of a new genus, I have very little to say, except that I agree with Lloyd that its nearest relative seems to be *Lycoperdon caelatum* Bull., which is also referred to *Calvatia*.

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Explanation of plate 20

The uppermost figure represents a mature specimen which has lost most of the peridium and gleba, while the left middle figure represents one which has lost all of the upper portion and is reduced to the sterile "stipe." The two lowermost figures show mummified young specimens. All the four specimens just mentioned were collected by C. C. Dobie and myself near Emerald Bay, Lake Tahoe, California, and are preserved in the herbarium of the University of California.

The right middle figure represents a portion of the peridium of a mature specimen, seen from above. It was collected in Sierra Valley, California, by D. T. Fowler, and is in the herbarium of the University of California.

All the figures were photographed and are reproduced at one half the diameter of the original specimens.

New North American lichens

A. Zahlbruckner

During the months of February and March, 1908, Mr. J. C. Blumer collected lichens in the vicinity of the Desert Botanical Laboratory near Tucson, Arizona, and sent them to Professor Bruce Fink to work over for an ecologic paper to be finished the following May. The time for critical study being short and Professor Fink being busy with the ecologic study, the writer was called upon to aid him in the determination of some of the more difficult species. The new species and the one variety described below result from my work upon the collection. The type specimens are deposited in the herbarium of the K. K. Naturhistorisches Hofmuseum at Vienna; type duplicates are in the possession of Professor Bruce Fink of Miami University, Oxford, Ohio.

Acarospora Carnegiei A. Zahlbr. sp. nov.

Thallus rufescenti-cervinus vel rufescenti-fuscus opacus, KHO–, $CaCl_2O_2$ leviter erythrinosus, hyphis medullaribus partis centralis squamorum substrato affixus, squamulosus, squamis plus minus congestis, angulosis vel anguloso-rotundatis, 0.3–1 mm. latis, 0.3–0.35 mm. crassis, modice convexis vel subplanis, subtus obscuratis, utrinque corticatus, cortice 30–40 μ alto, pseudoparenchymatico, cellulis angulosis, leptodermaticis, minutis; gonidiis infra corticem stratum latum continuum formantibus, palmellaceis, globosis, 9–13 μ latis, laete viridibus; hyphis medullaribus intricatis, non amylaceis. Apothecia in squamulis primum 1–3, evoluta tamen solitaria, immersa, 0.4–0.7 mm. lata, rotunda; disco concaviusculo vel plano, demum dilatato, dense caesio-pruinoso; margine proprio nigro, angusto, parum prominulo, integro vel subintegro; perithecio dimidiato, fuligineo, parum incrassato; epithecio pulverulento, crassiusculo, fuscescente, KHO olivaceo-lutescente, $CaCl_2O_2$–; hymenio decolore, usque 200 μ alto, I leviter caeruleo, dein rufescente et demum obscurato; paraphysibus crebris, filiformibus, conglutinatis, strictis, eseptatis, guttulis oleosis minutis et numerosis impletis, ad apices haud latioribus; ascis hymenio parum brevioribus, oblongo- vel ellipsoideo-clavatis, apice rotundatis et membrana incrassata cinctis, myriosporis; sporis decoloribus, simplicibus, ovalibus, ovali-oblongis vel oblongis, membrana tenuissima cinctis, 5–5.5 μ longis et ad 2 μ latis.

Species apotheciorum disco pruinoso et perithecio fuligineo dimidiatoque distincta.

On loose blocks of tuff or basalt.

Caloplaca amabilis A. Zahlbr. sp. nov.

Sect. *Eucaloplaca*. Thallus epilithicus, squamulosus, squamulis plus minus congestis, substrato haud arcte adpressis, rotundatis, subangulosis vel irregularibus, minutis, 0.3–0.8 mm. latis, convexiusculis, glaucis vel glauco-aeruginascentibus, nitidulis, ad marginem nonnihil paulum adscendentibus et tum anguste albo-marginatis, superne corticatus, cortice pseudoparenchymatico, cellulis minutis, sat pachydermaticis, luminibus rotundatis, decolore, in parte suprema cinerascente et KHO violaceo; gonidiis palmellaceis, cellulis 10–15 μ latis, infra corticem stratum sat crassum et continuum formantibus; medulla albescente, ex hyphis intricatis, non amylaceis formata. Apothecia erumpentia, demum sessilia, minuta, 0.25–0.3 mm. lata; disco primum dilute luteo, demum fulvo vel fulvo-aurantiaco, ceraceo, convexo, nitidulo, epruinoso; margine tenui, subintegro, mox depresso; excipulo tenui, ex hyphis tenuibus radiantibusque formato, gonidia haud includente; epithecio angusto, fulvo-aurantiaco, pulverulento, KHO purpureo; hymenio decolore, I violaceo-coeruleo; hypothecio decolore, ex hyphis intricatis formato, strato gonidiifero superposito; paraphysibus densis, simplicibus, tenuiter septatis, apicem versus constricto-septatis; ascis hymenio subaequilongis vel parum brevioribus, oblongis, ad apices cuspidato-rotundatis et ibidem membrana incrassata cinctis, 8-sporis; sporis in ascis biserialibus, obliquis, decoloribus, ellipsoideis, oblongo-ellipsoideis vel ovalibus, apicibus rotundatis, polari-diblastis, isthmo distincto, 9–13 μ longis et 5.5–7 μ latis.

On basaltic rocks and boulders.

Caloplaca elegans brachyloba A. Zahlbr. var. nov.

Sect. *Gasparrinia*. A typo distat lobis brevibus, ad 1 mm. longis, digitato-incisis.

On loose blocks of tuff and basalt.

Xanthoria modesta A. Zahlbr. sp. nov.

Thallus tenuissimus, effusus, siccus glauco-cinerascens, opacus, madefactus laete viridis, foliaceus, lobis minutis, ad 0.5 mm. latis vel minoribus, substrato plus minus adpressis vel ad margines leviter ascendentibus, congestis, inciso- vel digitato-lobatis, lobis valde brevibus, ad margines hinc inde granulatis, granulis thallo concoloribus, rhizinis nullis, utrinque pseudoparenchymaticus, cellulis leptodermaticis mediocribus, superne anguste infuscatus et KHO (sub lente visus) purpurascens; gonidiis palmellaceis, majusculis, 9–12 μ latis, laete viridibus, in thallo crebris. Apothecia minuta, ad 0.2 mm. lata, rotunda, dispersa vel raribus approximata, sessilia; disco e plano demum modice convexo, aurantiaco, epruinoso, KHO purpureo; margine thallino tenuissimo, thallo

concolore, integro, primum haud prominulo, demum depresso; excipulo pseudoparenchymatico, cellulis leptodermaticis, angulosis, gonidia continente; epithecio anguloso, pulverulento, KHO purpureo; hypothecio decolore, sat lato, pseudoparenchymatico; hymenio decolore, in parte suprema aurantiaco-ochraceo, 100–110 μ alto, I violaceo-coeruleo; paraphysibus filiformibus, crebris, concretis, ad apices paulum latioribus et constricto-septatis; ascis hymenio subaequilongis vel parum brevioribus, ellipsoideis vel oblongis, ad apices parum angustatis et rotundato-retusis, membrana ibidem bene incrassata, 8-sporis; sporis in ascis 2–3-serialibus, decoloribus, polari-diblastis, isthmo tenuissimo, late vel angustius ellipsoideis, 9–12 μ longis et 7–8 μ latis.

Xanthoria ob anatomiam thalli; species peculiaris.

On basaltic rocks.

Leptogium arizonicum A. Zahlbr. sp. nov.

Sect. *Euleptogium*. Thallus olivaceo-obscuratus, modice gelatinosus, imbricato-lobatus, lobis rotundatis vel inciso-rotundatis, ascendentibus, concavis, tenuibus, sorediis et isidiis destitutis, utrinque corticatus, cortice e serie unica cellularum formato magnarum et leptodermaticarum, parte centrali thalli gonidia nostocacea numerosa et approximata continente. Apothecia superficialia, sessilia, basi angustata, usque 1 mm. lata, primum bene concava, fere gyalectoidea, demum subplana vel modice convexa; disco obscurato, epruinoso, nitidulo; margine proprio tenui, integro, parum prominulo, extus grosse pseudoparenchymatico, cellulis in seriebus 3–4 angulosis, intus parum gelatinoso; perithecio angusto, decolore, pseudoparenchymatico, cellulis minutis; hypothecio decolore ex hyphis intricatis formato; hymenio subdecolore, superne obscure cinnamomeo-fusco, I intense coeruleo, demum obscurato; paraphysibus conglutinatis, simplicibus, septatis, ad apices clavatis; ascis oblongo-clavatis, hymenio subaequilongis, 8-sporis; sporis decoloribus, ellipsoideis vel ovali-subfusiformibus, primum 3-septatis, demum depauperato-muralibus, 18–27 μ longis et 7–12 μ latis.

Species habitu collemaceo et sporis pauciseptatis distincta.

On earth at the base of a northward-facing basaltic cliff.

Heppia placodizans A. Zahlbr. sp. nov.

Thallus in centro verruculoso-squamulosus, in margine effiguratus, olivaceo- vel umbrino-fuscus, opacus, KHO–, $CaCl_2O_2$–, squamulis centralibus plus minus congestis, parvis, 0.2–0.25 mm. latis, subtus fuscis, rotundis vel rotundatis, alte convexis vel semiglobosis, hyphis medullaribus centralibus substrato affixis, lobis marginalibus ad 2 mm. longis, angustis, subcylindricis, semel vel iteratim furcatis, contiguis, omnino pseudoparenchymaticus, cel-

lulis parvis angulosis, leptodermaticis, gonidiis scytonemeis, cellulis rotundatis vel late ovalibus, 7–8 μ longis, membrana tenuissima cinctis. Apothecia punctiformia, parum visibilia, immersa; disco impresso, punctiformi, nigricante et opaco; perithecio proprio non evoluto; hypothecio decolore, ex hyphis intricatis formato; hymenio decolore, solum superne olivaceo, 120–130 μ alto, I rufescente, imprimis ascis; paraphysibus increbris, simplicibus, latiusculis, ad 3.5 μ crassis, leptodermaticis, apicem versus tenuiter constricto-septatis; ascis hymenio subaequilongis, oblongo-clavatis, apicibus rotundatis vel angustato-rotundatis, membrana ibidem valde et calyptratim incrassata cinctis, myriosporis; sporis decoloribus, simplicibus, globosis, membrana tenuissima cinctis, 3.5–3.7μ latis. Conceptacula pycnoconidiorum immersa, globosa; perithecio pallido; fulcris exobasidialibus; basidiis filiformibus, in parte inferiore paulum latioribus, pycnoconidiis multum longioribus; pycnoconidiis ovalibus, ovali-oblongis vel oblongis, ad 2 μ longis.

Species distincta, thallo placodiali et sectionem propriam format. Haec sectio nominanda est **Placoheppia** A. Zahlbr.

On basaltic boulders.

Heppia deserticola A. Zahlbr. sp. nov.

Thallus cervinus, opacus, KHO–, $CaCl_2O_2$–, squamosus, squamis demum plus minus congestis, 0.6–2 mm. altis, e rotundato sat irregularibus, subplanis, tenuibus, ad 0.2 mm. altis, in margine demum breviter inciso-lobatis, gompho centrali substrato affixis, subtus caeterum fuscis, omnino pseudoparenchymaticis, cellulis angulosis, leptodermaticis, gonidiis scytonemeis fere totam crassitudinem thalli occupantibus et solum in parte basali thalli anguste deficientibus. Apothecia in squamis solitaria, demum dilatata, usque 0.8 mm. lata, immersa; disco thallum subaequante, parum concavo vel subplano, rufescenti-nigricante, opaco, margine thallino angustissimo integro parum prominulo cincta; perithecio non evoluto; epithecio olivaceo-fusco, KHO rufo; hymenio dilute rosaceo, 160–170 μ alto, I vinose rubente; hypothecio angusto, decolore, non pseudoparenchymatico; paraphysibus tenuibus, strictis-filiformibus, simplicibus; ascis hymenio aequilongis, oblongo-clavatis, myriosporis; sporis decoloribus, simplicibus, heteromorphis, late ovalibus vel late ellipsoideis ovalibus, oblongis vel ovali-oblongis, membrana tenuissima cinctis, 7–11 μ longis et 3.5–5 μ latis.

Accedit ad *Heppiam leptopholidem* Nyl. et *Heppiam Hassei* A. Zahlbr., a priore distat squamis non nigro-marginatis et sporis non globosis, a posteriore thallo pallidiore et sporis longioribus polymorphisque.

On basaltic boulders.

K. K. NATURHISTORISCHES HOFMUSEUM, WIEN.

Two new grasses from the West Indies

GEORGE V. NASH

Panicum Grisebachii sp. nov.

A perennial with long branching creeping stems, long lanceolate leaf-blades, and rather small panicles. Stems smooth and glabrous, the lower nodes rooting: leaf-sheaths on the lower parts of the stem and branches shorter than the internodes, on the upper portions overlapping, hispid with ascending hairs, ciliate on the margins; ligule a narrow scarious ring about 0.5 mm. wide; blades ascending, 6–12 cm. long, up to 1 cm. wide, lanceolate, long-acuminate at the apex, somewhat narrowed toward the rounded base, glabrous on the upper surface, shortly pubescent on the lower: panicle 5–10 cm. long, minutely pubescent, its ascending branches 2–3 cm. long and usually bearing but few spikelets: spikelets finally becoming black, 4–4.5 mm. long, 3–4 mm. broad, the first scale a little less than one half as long as the spikelet, orbicular, apiculate, 7–9-nerved, villous at the apex, clasping the base of the spikelet, the second scale orbicular, 7–9-nerved, villous at the obtuse apex, the third scale orbicular, obtuse, 9–11-nerved, enclosing a palet, the fourth scale chartaceous, enclosing a palet of similar texture and a perfect flower.

At present this is known only from Cuba. Type specimen collected in the vicinity of Madruga, by Britton & Shafer, *no. 758*, March 28, 1903, in the herbarium of the New York Botanical Garden. I would also refer here the following: *Baker 3817*, Pinar del Rio, October 28, 1904; *Rugel 187*, Matanzas, 1849; *Wright 3457*.

This is the Cuban plant which has been commonly but erroneously referred to *Panicum martinicense* Griseb. That is quite another grass, differing in its erect habit, broader leaf-blades, and pointed spikelets.

Pharus parvifolius sp. nov.

A perennial grass with branching stems which creep extensively and root at the lower nodes, and small elliptic-lanceolate leaf-blades which are broadest below the middle. Stems shortly villous, especially above: leaves numerous; sheaths smooth and glabrous, over-

lapping; ligule a lacerated scarious ring about 1 mm. wide; blades 6–12 cm. long, 1.5–3 cm. wide, on petioles up to 1.5 cm. long, elliptic-lanceolate, rounded or somewhat cuneate at the base, long-acuminate at the apex, smooth and glabrous, with 3 or 4 rather indistinct primary nerves on each side of the midrib: panicle shortly villous, finally much exserted, consisting usually of a single branch which is longer than the main axis of the panicle: staminate spikelets 2.5–3 mm. long, glabrous: pistillate spikelets 10–12 mm. long, the empty scales about one half as long as the spikelet, the flowering scale 10–12 mm. long, cylindric, often somewhat curved, densely glandular-pubescent with spreading hairs, excepting the somewhat obtuse, short-cuneate apex.

This interesting plant is at present known from Haïti, Cuba, and Porto Rico. Type specimen collected by the writer in deep shade in a ravine called Les Roches, a few miles to the west of Plaisance, Haïti, on August 11, 1905, at an altitude of about 540 meters, *Nash & Taylor 1482*, in the herbarium of the New York Botanical Garden. The following specimens are also referred here: *Maxon 4155*, near Jaguey, Yateras, Oriente, Cuba, April 24, 1907, 420–510 meters; *Eggers 4939*, Loma del Jaguey, Cuba, March, 1889, 800 meters; *Sintenis 6308*, Arecibo, Porto Rico, February 28, 1887 (sterile).

In the character of the spikelets, this is related to *Pharus glaber* H.B.K. It is, however, at once distinguished by its habit, this having a long creeping stem which branches at intervals, the plants thus forming large open mats, a feature quite unusual in the genus. The leaf-blades are also quite different in size and shape, being broadest below the middle and long-acuminate, whereas in *P. glaber* they are broadly oblanceolate-elliptic, that is, broadest above the middle, and much larger. The writer saw the two species growing together in Haïti, and the differences of habit and leaf-blade are very marked. In addition to the above differences, the panicle of the new species is much smaller, and usually reduced to a single branch, giving the appearance of a panicle broader than long.

NEW YORK BOTANICAL GARDEN.

The generic name Bucida

N. L. Britton

The name *Bucida* was proposed by Linnaeus in 1759 (Syst. ed. 10, 1025) for the *Buceras* of P. Browne (Civil and Nat. Hist. Jam. 221), published three years previously. Both names are derived from the fancied resemblance of certain outgrowths from

FIGURE 1. Hypertrophied fruit of *Bucida Buceras*, one half the natural dimensions.

the inflorescence of the tree to the horns of a bull, as expressed by P. Browne as follows: "On the flower-spikes of this tree you may sometimes find one or more fructifications, that shoot into a

monstrous size, being seldom under three inches in length, though never above a line and a half in diameter; and something in the form of a bull's horn."

The tree, known in Jamaica as the black olive, is valuable for its timber and grows commonly in swamps and along streams near the coast throughout the West Indies, extending north to south Florida and the Bahamas.

While boating on the Ferry River, a few miles west of Kingston, Jamaica, one of the places where Browne studied this tree, in company with Mr. William Harris, on April 10, 1908, I was much interested in observing a tree whose limbs hung over the water, bearing quantities of the structures referred to by Browne as "fructifications," and I easily obtained good specimens from it. On this tree the peculiar outgrowths are borne near the ends of the spikes, as illustrated by Browne on his plate 23, fig. 1; they are linear, elongated, and vary from 8 to 16 cm. in length, with a diameter of from 2 to 3 mm. when young, characteristically curved and very nearly circular in cross-section; when old, they split irregularly along one side, after becoming about 4 mm. in diameter, and expose a black internal mass, which suggested to me a possible fungal origin of the outgrowth; I requested Dr. Murrill to examine the specimens, but he could find no fungus, though he did find mites, whereupon we sent specimens to Professor Mel. T. Cook, who has recently furnished us with the following account of his examination of them. The accompanying figure represents a typical form of these interesting galls, remaining attached to the upper end of the inflorescence after the fruits have fallen away.

NEW YORK BOTANICAL GARDEN.

The hypertrophied fruit of Bucida Buceras

MELVILLE THURSTON COOK

Specimens of the enlarged fruits of *Bucida Buceras* were recently sent to me from the New York Botanical Garden by Dr. W. A. Murrill for examination and my attention was called to the fact that they contained mites in considerable numbers. The material was collected in Jamaica by Dr. N. L. Britton.

FIGURE 1. *A*, outline of normal fruit of *Bucida Buceras*, 1¼ natural size; *B*, outline of galled fruit of *Bucida Buceras*, 1¼ natural size.

A careful examination of the material confirmed the observations of the workers in the New York Botanical Garden and also convinces me that the hypertrophy is due to mites and may be considered as a fruit-gall produced by the action of an undescribed species of *Eriophyes*.

An anatomical study of these enlarged fruits and comparison with the anatomy of the normal fruits present the following facts: The fibro-vascular tissues are increased in quantity but otherwise are unchanged. The parenchyma tissue was increased in quantity and also formed into great numbers of papilla-like growths (FIGURE 2) which projected into and practically filled the ovarian chamber to the sacrifice of the seeds. At the base of the pod these parenchyma-cells had evidently reached their maximum of growth and were undergoing degeneration. They contained considerable quantities of yellowish-brown

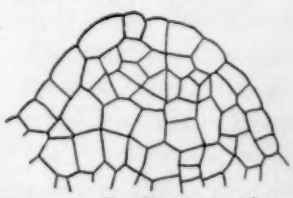

FIGURE 2. Papilla of parenchyma from ovary chamber.

substance, a part of which was tannin. Near the tip of the pod the cells were clear and evidently in a very active growing condition. The intermediate cells showed every stage between those of the two ends.

The mites were scattered throughout but were much more abundant near the tip than in any other part. Furthermore, many of those near the tip were smaller than those near the base.

Several species of mites produce hypertrophied conditions in plants grading from a simple erinium to well-defined galls. The simplest erinium may consist of unicellular outgrowths from the epidermis while the more complex forms develop masses of multicellular trichomes which are frequently accompanied with swellings of the parts from which they arise. In some instances the normal organs of the plant (usually the leaves of floral organs) become very much convoluted, while in other cases there is a swelling in which there is a well-defined cavity containing the mites. In most cases there are numerous papilla-like growths of the parenchyma projecting into these cavities.

When these hypertrophies reach a maximum growth, there is always a deposit of tannin. At this time the mites migrate towards the tip and attack the young and more actively growing parts.

From this discussion it will be readily seen that the anatomical character of these abnormal fruits corresponds with those of the well-defined *Eriophyes* galls.

AGRICULTURAL EXPERIMENT STATION,
NEWARK, DELAWARE.

Color variation in some of the fungi

FRED JAY SEAVER

The present short paper is the outgrowth of a year spent at the New York Botanical Garden as Columbia University fellow in botany, during which a large amount of time was spent in the study of the North American Hypocreales, the main results of which are still unpublished. The order Hypocreales belongs to the group of fungi commonly known as the Pyrenomycetes and is distinguished from the other orders of the group by the absence of black color. Instead of the black charcoal-like appearance the plants of the order show almost every conceivable shade, the individuals as a whole probably being more brilliantly colored than those of any other group of fungi and doubtless rivaling, in this respect, any other group of plants. But notwithstanding their brilliant colors, many of the plants of the order are so small and occur in such unexpected places that they escape the eye of the casual observer and often that of the more trained collector as well.

Probably no character is of more importance, if properly used, in the determination of species among the fungi than that of color, and at the same time no character has been so sadly misused. More synonyms in the present order owe their origin to lack of knowledge of the amount of variation of color in the various species of the order than to any other one fact. To describe a new species of maple which is distinguished from some of the species already described by the fact that the leaves are red instead of green would be considered absurd by students of higher plants, yet many species of fungi have been "made" on characters which are just as striking and also just as valueless as the one just suggested. The few corrections which are set forth here are made, not in the spirit of criticism, but with the hope that they may prevent some of the similar errors which otherwise might occur in the future. It is much more difficult to study the life-history of plants which are but a fraction of a millimeter in diameter than that of the higher plants which stand often many meters in height. Yet, if the existence of

these minute organisms is worthy of record at all, as the true lover of science will admit they are, they should deserve just as careful study through all the phases of their life history as do the higher plants, which on account of their large size force themselves upon our attention.

One of the first observations of color variation to come under the eye of the writer was in connection with the study of *Nectria purpurea* (L.) W. & S. (Jour. Myc. **13**: 51), which is more commonly known under the name *Nectria cinnabarina* (Tode) Fries. While collecting in the vicinity of Mt. Pleasant, Iowa, on November 10, 1905, a brush pile was found to be almost entirely covered with the plants of this species, which showed the characteristic cinnabar-red color and a collection of the material was made at this time. A few months later the same spot was visited again with the hope of making a second collection of the same species. The old plants still persisted but were so changed in color as to be scarcely recognizable, the perithecia having become very dark brown and in some cases entirely black. A second collection was made at this time and when compared with the first showed such a marked difference that, were color alone considered, they would constitute two well-defined species. Yet, these two specimens were known to represent the same species collected at different times. A careful study of this species in the laboratory and field has shown the range of coloration to be from bright cinnabar-red when collected in good condition to dull red, light brown, dark brown and finally black, with an infinite number of intermediate shades, the change coming about through weathering and varying conditions of moisture. The originally bright color of the plants and their xerophytic nature, which enables them to persist for a long time, often several months, after maturity, are sufficient to explain the cause of these variations.

In working over the various species of the genus *Nectria* preparatory to a monograph, several species which had been recorded in previous North American monographs had been tabulated in the notes of the writer as "suspicious characters" on the ground that the descriptions were too brief and indefinite to give any conception as to the real nature of the specimens described and in most cases gave no character which could be considered as dis-

tinctive of the species except color, which in this genus is very uncertain. Several of the species belonging to the doubtful list were from the notorious "B. & C." collections. In every case an attempt has been made to gain access to the type specimen of such species. Through the authorities of the New York Botanical Garden we have succeeded in securing several cotype specimens from the Royal Botanic Gardens at Kew and here it might be well to acknowledge the liberality and promptness with which such requests were granted by those in charge of the Botanic Gardens of England. Where specimens were too fragmentary to divide, pencil sketches were carefully prepared which have aided much in shedding light on some of the mysteries surrounding the group under consideration, although drawings do little to clear up the color question.

Some of the doubtful species of which the cotypes have been examined are *Nectria Russellii* B. & C., *Nectria offuscata* B. & C., and *Nectria nigrescens* Cooke. The first two were originally described in the following manner (Grevillea **4**: 45): "Cespitose, red inclined to brown, finally collapsing; spores cymbiform, 1-septate, 15 to 20 mic. long," and "Cespitose, dingy red-brown, minutely granulated, ostiolum depressed; asci clavate; spores 2-seriate oblong, 4 times as long as broad." In neither of these descriptions is there a single character mentioned which would distinguish the supposed species from *Nectria purpurea* (L.) W. & S., when the range of coloration of this species is taken into consideration, and a careful examination of the cotype specimens of each of these species also fails to reveal any valid specific character. The third of these doubtful species is described (Grevillea **7**: 50) as follows: "Cespitose, red, at length turning black, smooth, ostiolum papilliform; asci cylindrical, spores elongated-elliptical, 1-septate, 18 by 6 mic.; stylospores on the same stroma, some ovate brown (5 by 3 mic.), others linear (6 by 2 mic.), hyaline." The only character in this description which might mark a new species is the presence of the brown stylospores and there is no evidence given that these are connected with this plant even though present on the same stroma. Examination of a specimen of this species from Kew shows unmistakable evidence of age and partial decay. The perithecia are blackened and in many cases crumbled and it is dif-

ficult to find asci and spores, all of which are indications of the age of the specimens at the time of collection. The brown stylospores mentioned in the description were not seen and even though present, as suggested above, there is no evidence that they form a part of the life-history of the plant with which they are found. The specimen has every appearance of being a discolored specimen of *Nectria purpurea* (L.) W. & S.

Nectria Meliae Earle (Bull. Torrey Club **25**: 364) is said in the original description to be distinguished from *Nectria purpurea* (L.) W. & S. by the darker color of the perithecia and a slight variation in size. Examination of specimens of this species in the herbarium of the New York Botanical Garden shows no grounds for its separation.

No species deserves more careful study than the one now under consideration for the reasons that it is common and widely distributed, occurs on nearly every kind of tree and shrub, and, being a persistent form, shows much variation in color as well as in other characters which would naturally be affected with age. A large number of the closely related so-called species which have been described are distinguished primarily on color and if every shade of color be accepted as a valid specific character we might have an infinite number of "printer's ink" species created from the one form as set apart by nature.

Another case of color variation has been noted in *Hypocrea gelatinosa* (Tode) Fries (Fung. Meckl. Sel. **2**: 46. *f. 123, 124*). Specimens of this species collected by the writer show the very young plants to be of a bright lemon-yellow color, but as the spores mature they become olive-green, giving to the stroma a mottled appearance. The whole stroma then becomes darker until it assumes a dirty green, finally becoming nearly black with age. In fresh specimens all of these variations have been seen on the same substratum and the relation can be traced from one to the other.

Hypocrea chlorospora B. & C. (Grevillea **4**: 14) is characterized as being distinguished from the above by the black stroma, the color of the spores being the same in both species. While no authentic specimen of this species could be secured, it seems very doubtful if it is distinct from *Hypocrea gelatinosa* (Tode) Fries.

In the Ellis collection at the New York Botanical Garden is a specimen of green-spored *Hypocrea* labeled, evidently in the handwriting of Mr. Ellis, "*Hypocrea viridis* n. s." and the stroma described as being dull greenish within and without, and a note is added stating that it could not be *Hypocrea chlorospora* B. & C. for the reason that that species was characterized by a black stroma. Another note, added, apparently, at some later time, stated that as the plant dried it became darker and might after all be *Hypocrea chlorospora* B. & C.

Still another specimen of green-spored *Hypocrea* was described by Mr. Ellis as being at first yellowish. Both of these specimens when examined in 1906 showed the stromata to be entirely black with a greenish bloom, which came about from the dusting out of the spores from the perithecia.

The notes on the specimens in the Ellis collection, as well as the observations of the writer on both herbarium and fresh material which has been collected often and in various localities, tend to confirm the opinion that *Hypocrea chlorospora* B. & C. is identical with *Hypocrea gelatinosa* (Tode) Fries and that the range of coloration in this species is from bright golden or lemon-yellow in very young specimens to dirty greenish as the spores mature and finally black with a greenish bloom, which comes from the dusting out of the spores from the perithecia as the specimens become more aged.

This view is strengthened by the fact that Tode in his original description recognized two varieties, *viridis* (green) and *lutea* (yellow), and Fries later recognized a third, *umbrina* (dark).

Hypocrea apiculata Cooke & Peck (Ann. Rep. N. Y. State Mus. **29**: 57) also shows some rather marked color changes. This species has been studied from numerous collections of fresh material, the identification of which has been confirmed by Mr. Peck, one of the authors of the species. In specimens collected in good condition the stromata are of a bright orange-yellow color. If specimens are dried and exposed to the light for some time the color becomes lighter until it assumes a dirty yellowish and finally becomes almost white or a dirty yellowish-white. In this case the bleached specimen might easily be mistaken for a distinct species considering the importance which has usually been attached to the color character in this genus.

One of the most striking cases of color variation has been observed in *Hypomyces lactifluorum* (Schw.) Tul. (Syn. Fung. Car. 4). This species has been studied from various exsiccati in the herbarium of the New York Botanical Garden, including both American and foreign specimens and during the past season ample opportunity has been afforded to carry on field observations with the same species.

Hypomyces purpureus Peck (Bull. Torrey Club **25**: 327) is stated in the original description to differ from *Hypomyces lactifluorum* (Schw.) Tul. only in the color of the stroma, which is purple instead of orange-yellow. Studies in the herbarium convinced the writer that the two species were identical, but for lack of suitable material the matter could not be demonstrated absolutely. From recent studies in the field the fact has been established beyond the shadow of a doubt.

During the last season in a piece of aspen timber on the Red River near Fargo, North Dakota, numerous specimens of *Lactaria* were found, all of which were entirely parasitized by *Hypomyces lactifluorum* (Schw.) Tul. The normal color of the plants of this species is a bright orange-yellow and the striking character of the color might be illustrated by the following incident: The collector on returning from a collecting trip with a basket partially filled with the plants of this species chanced to pass a vehicle in which a little boy was heard to remark to his mother "O mama, see the big basket of orange peel!" While most of the specimens collected showed the normal orange color, in looking over the field a number were noted which showed the purple color characteristic of *Hypomyces purpureus* Peck. But in every such case the host showed evidences of decay and in advanced cases the host had become soft and fallen in a heap. In these extreme cases of decay the purple color was very prominent and would readily suggest to the mind of the collector the association of the purple color with decay.

In order to test the matter a simple experiment was conducted. A plant which showed the normal orange-yellow color was selected and cut into two pieces. The one was placed in a moist chamber and the other dried at once. As the moist specimen decayed, it assumed the characteristic purple color of *Hypomyces purpureus*

Peck and the other half which was dried immediately retained the orange-color of *Hypomyces lactifluorum* (Schw.) Tul. thus proving the identity of the two species. Dried specimens of each were mounted in the herbarium of the writer and kept for future reference.

Colors are not equally changeable in all cases, neither are the conditions which bring about these changes the same for different species. In *Hypocrea citrina* (Pers.) Fries, which is normally of a bright lemon-yellow color, the dried specimens have been exposed to the light for several months and no change in color detected, while specimens of *Hypomyces apiculata* Cooke & Peck are entirely bleached when treated in the same manner. However, *Hypocrea citrina* (Pers.) Fries, if exposed to conditions of excessive moisture, loses its bright color and takes on a dull yellow, approaching a brown.

The conclusions of the present paper are that the evidence, which is adequate in most cases, suggests the reduction of the following species which are based primarily on color to the list of synonyms: *Nectria Russellii* B. & C., *Nectria offuscata* B. & C., *Nectria nigrescens* Cooke, and *Nectria Meliae* Earle, being based on aged and more or less discolored specimens of *Nectria purpurea* (L.) W. & S.; *Hypocrea chlorospora* B. & C. on an aged specimen of *Hypocrea gelatinosa* (Tode) Fries; and *Hypomyces purpureus* Peck a condition of *Hypomyces lactifluorum* (Schw.) Tul. in process of decay. Further, that the description of new species in the present order based on color *alone*, until the color variation of the various species or the order can be determined, leads to nothing but confusion. Only a few of the more striking cases of color variation have been mentioned here and those with the hope of impressing upon co-workers the necessity of more careful field study rather than a haphazard description of new species based on characters which may prove constant but which in many cases are most changeable.

A monograph of the North American Hypocreales is in course of preparation by the writer and material is desired from any part of North America.

In preparing this paper I am indebted to the New York Botanical Garden for unrestricted use of library and herbarium,

including the Ellis collections, and to the Royal Botanic Gardens of England for the several cotype specimens referred to in the paper; also to Mr. C. H. Peck for the determination of one species used and to the late L. M. Underwood for suggestions on various points.

NORTH DAKOTA AGRICULTURAL COLLEGE,
AGRICULTURAL COLLEGE, NORTH DAKOTA.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1907)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions their kindness will be appreciated.

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